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Keywords

Local food, sustainability, supply chain management, horizontal collaboration, food hubs

Disciplines

Operations Research, Systems Engineering and Industrial Engineering

Comments

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A Framework for Collaboration among Regional Food System Participants

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Abstract

Horizontal collaboration can benefit supply chain partners by increasing their collective competitiveness. However, each participant in the collaboration typically maintains its own individual business objectives. Therefore, such collaborations require a standard operational framework that specifies the allocation of participant responsibilities and benefits. While horizontal collaboration in regional food supply chains is common, very few participants have adopted this type of standard framework. As a result, the sharing of resources and information among partners tends to be inefficient and potentially contentious. This paper describes our efforts to formalize a supply chain collaboration that has developed among several regional food hubs and small-scale food producers in Iowa. The focus of the project has been the design and implementation of a flexible and affordable inventory tracking system that will allow the participants to accurately share logistics information with one another in real time. While the project has faced significant financial constraints, the shared social mission and trust that exists among the participants has facilitated a successful pilot study. The overall goal of the project is to support the sustainable growth and long-term resilience of Iowa's regional food system while ensuring that each participant is able to maintain sufficient autonomy.

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1. Introduction

Regional food systems involve the production, distribution, and consumption of food within a given geographic region. Regional food supply chains (RFSCs) are often referred to as short food supply chains, because they are characterized by shorter transportation distances and more direct communication between producers and consumers than conventional food supply chains [1]. The operations and objectives of RFSC participants are typically very different from those of conventional supply chain participants. RFSCs promote social sustainability by creating connections between local farmers and consumers [2]. They also promote economic sustainability by providing fair prices to small-scale farmers and treating them as strategic business partners [3, 4]. Regional food systems can also support environmental sustainability by reducing transportation distances between producers and consumers and encouraging sustainable production methods [5].

However, regional food system participants are typically small or mid-sized organizations that may have very little experience in distribution and supply chain management [6]. Therefore, their distribution networks tend to be fragmented and less efficient than the centralized distribution networks of conventional food systems [7]. A lack of systematic supply chain structures has led to the failures of many local food projects [8]. Food hubs can potentially alleviate some of these problems for RFSCs. The USDA defines a food hub as "a business or organization that actively manages the aggregation, distribution and marketing of source-identified food products primary from local and regional producers to strengthen their ability to satisfy wholesale, retail and institutional demand" [9]. Food hubs enable producers to access larger-volume markets and provide a single pick-up and drop-off point for food distribution. They can make regional food sale profitable for producers and affordable for consumers. However, food hubs often struggle with inadequate physical infrastructure, and a lack of available resources (i.e., labor and transportation) has proven to be a major barrier to their growth and success [10].

To overcome these challenges, regional food systems can benefit from horizontal collaborations among their participants. Horizontal collaboration is defined as mutually beneficially relationships between two or more business participants of separate competitive or non-competitive supply chains fulfilling similar purposes or services [11]. Many business organizations from various industry sectors have attempted to use horizontal collaborative supply chain strategies to maintain their individual competitiveness [12]. These organizations cluster their logistics activities and assets (e.g., through shared transportation and processing facilities) to improve efficiency and reduce environmental load [13]. This requires organizations to emphasize relationship-building and networking. When done successfully, collaboration efforts can lead to improved logistics performance for each participant [14].

RFSC participants are interdependent, and “coopetition” – cooperation with competitors – among them is a collective strategy that can expand markets and support prices [15]. Collaborative logistics can provide producers better access to processing facilities and distribution networks, thereby improving market access for their products [16]. For example, multiple producers selling to the same food hub can aggregate deliveries to reduce transportation costs and create fewer deliveries for the food hub [17]. Horizontal collaboration is also recommended for food hubs, including sharing deliveries and taking advantage of group purchasing organizations [18]. To generate additional revenue, a food hub can lease space in its building or offer delivery services to other organizations or larger producers [17]. While collaboration can reduce costs for regional food organizations, it can also slow decision making, since decisions are made by a group rather than individuals [19]. Additionally, to reduce risk and increase the likelihood of successful collaboration among regional food organizations, a contract specifying the responsibilities of each involved party is recommended [20].

There are examples of informal horizontal collaborative networks that have emerged in RFSCs. For example, Eden Natural, a pork producer in Iowa, saved \$0.08 per mile in transportation costs with an annual savings of over \$25,000 by combining their long haul trucking with another company [21]. Also Driftless Organics, a farm in Wisconsin, works with nearby producers and holds regular meetings to share ideas on how to further increase the efficiency of their joint distribution efforts [22]. However, these informal systems use word of mouth and informal cost sharing methods, which can have negative effects on the trust and cooperativeness among the collaborating members [12]. Therefore, these collaborative systems would benefit the adoption of a formal collaborative framework. A formal collaborative framework clearly defines guidelines for member selection, the roles and responsibilities of each member involved, who will own the leadership, how the benefits will be shared, and the information-sharing standards between the collaborating members [23].

In this paper we will focus on the steps taken to formalize an informal horizontal collaboration effort of four Iowa food hubs [24]. The four food hubs collaborate with each other to reduce the overall transportation costs of moving products from producers to the food hubs. However, there is currently no coordinated inventory tracking effort among the food hubs, nor is there a formal platform to track the movement of products throughout the system. In addition, communication between the food hubs typically occurs via informal means (i.e., phone calls and text messages). The absence of a systematic information-sharing mechanism in this collaborative system has led to suboptimal system-wide logistics and frequent delivery errors. Additionally, the food hub managers lack a systematic method for allocating and tracking the costs of shared physical infrastructure and warehousing services, which is necessary for successful and sustained collaboration. This paper describes an ongoing effort to develop a formal framework for the Iowa food hub system.

2. Review of Horizontal Collaboration Mechanisms for Food Hubs

Several different types of collaboration frameworks have been previously proposed for food hubs. Collaborative relationships between organizations can vary in complexity, based on the nature of information shared and degree of interaction between the collaborating partners [23]. They have been broadly described into three different levels, based on the amount of information exchanged between the collaborating organizations: operational, strategic, and co-evolution [25]. As the level of collaboration increases, participating members become more interdependent, and there is a greater level of investment and reallocation of resources across the network [26].

Operational – Operational relationships require low commitment, few interactions, and minimal information sharing among partners. These networks work together to optimize specific logistics activities. Their ventures involve the lowest risk and do not typically achieve large-scale network improvements. For example, the development of a farmer’s market hub was proposed in Los Angeles to distribute locally produced food to institutional and wholesale

customers [27]. This hub would allow farmers to sell excess inventory collectively to wholesale customers to obtain better prices for their products. It would also enable resource sharing (e.g., trucks). This type of collaboration requires some information sharing among the collaborating farmers, such as product availability. However, it would not require a significant investment in the infrastructure. Participating farmers would also be able to maintain their autonomy and could easily leave the network, thereby limiting their risk. Since this network requires low risk for entering participants and limited sharing of sensitive information, this type of collaborative network can be considered as operational.

Strategic – Strategic partnerships involve the sharing of key infrastructures and/or sensitive information among the partners. Organizations in strategic partnerships jointly plan operations, agree on objectives, and share strategic information, such as customer demand, forecasts, and operational capacities [28]. For example, in Virginia a network of food hubs was proposed in which the IT systems of the participating hubs would be connected via a common IT solution provider. This would allow producers to sell at multiple hubs, thereby facilitating sales to institutional and restaurant buyers [29]. The proposed network would require that the food hubs invest money to support the development of the IT infrastructure; however, the investment would be relatively minimal, because the network aims to connect an existing system. Therefore, this kind of network is associated with low to intermediate risk for participating members. However, this type of network would require the food hubs to share sensitive demand and supply information with the other hubs in the network. Therefore, this type of collaboration can be considered strategic.

Co-evolution - A co-evolution relationship involves complex information exchanges and intertwined business interactions between partners that can lead to the creation of a new entity, such as a consortium or a joint venture. These networks involve a high level of trust between business partners and therefore involve the greatest level of risk for individual organizations; however, they are capable of handling large-scale network improvements and advancements. An example of this kind of collaboration is described in a study that was conducted to assess the feasibility of a statewide IT platform for food hubs in Michigan. This system would lead to improved performance and better communication among the food hubs, food producers, and buyers [30]. The proposed IT platform aims to interface with the existing internal software of the local food hubs. This would provide buyers and food hubs better access to farm products across the state, as well as improving the selling radius of the producers. However, the proposed IT platform would require significant start-up and maintenance costs, which increases the investment and risk for all stakeholders. Also, this type of network would lead to significant interdependency among the members. Therefore, this suggested collaboration follows a co-evolution model with a vision of uniting all participants in a single network, with the aim of maximizing local food distribution throughout Michigan.

While these proposed networks provide useful conceptual frameworks for collaboration in RFSCs, no formal documentation on the actual implementation, outcomes, and challenges of these frameworks exists in the literature. This paper extends the existing literature on RFSC collaboration by describing how supply chain collaboration methods have been applied to a collaborative network of four food hubs in Iowa [24].

3. Collaboration Framework for a Food Hub Network in Iowa

The Iowa food hub network started as an operational-level relationship between the hubs that relied on informal communication, participant independence, and a lack of standardization across the network [24]. The only information that was shared between the hubs was sales data, which facilitated transportation collaboration. However, without structured information sharing, this collaboration resulted in frequent delivery errors, which caused problems for customers. The first step in improving and strengthening this horizontal collaboration was to develop operational-level mechanisms. Improving the network at its current level would prepare the network to enter into the strategic or potentially the co-evolution level of collaboration in the future. The first task, as proposed by Craven, Mittal & Krejci (2016), was to develop standard packaging and labeling guidelines for the food producers in the RFSC network. This would not require any additional information exchange, but it would help to formalize the existing information-sharing procedures. However, standardization would necessarily reduce producers' independence.

Several different methods were considered for standardization. Craven, Mittal, & Krejci (2016) proposed the use of barcoding or RFID tags to enable the exchange of a large amount of information quickly when transferring products from one location to another (e.g., from a producer's location to a food hub). However, it was difficult to adopt these technologies because of the significant financial constraints the food hubs face due to their low operating income.

Therefore, in order to keep the system low-cost and easily maintainable by the food hub managers, the idea of implementing barcodes or RFID tags was not adopted. The next option was to develop a system that would automatically generate labels for producers to place on each product box, with a content description and unique SKU numbers for each product. Tracking the products at the SKU level would help to trigger appropriate action in the event of a missing product. However, it was discovered that producers often bundle multiple different products into a single box to save on cost. Therefore, a content description would require either multiple of labels for each box, or a long list of information on a single label. Additionally, each food hub has different item numbers and descriptions for the same items, which prevented the use of a common SKU identifier on the labels. Faced with these challenges, it was decided that product tracking would be implemented at the box level, where each box could potentially hold multiple products from a single producer. The sample of the label design is shown in Figure 1.

Producer Name	
1 / 14	PO Number
	Food Hub Name

Figure 1: Sample producer label from the pilot study

The label contains the box number, as well as the total number of boxes to be labeled for each producer-food hub combination (e.g., box 1 out of 14 total boxes). The final labeling system was successfully piloted among the four food hubs and four of their producers, which are shown in Figure 2, where the number on each producer symbol indicates the food hubs through which the producer distributes its products.

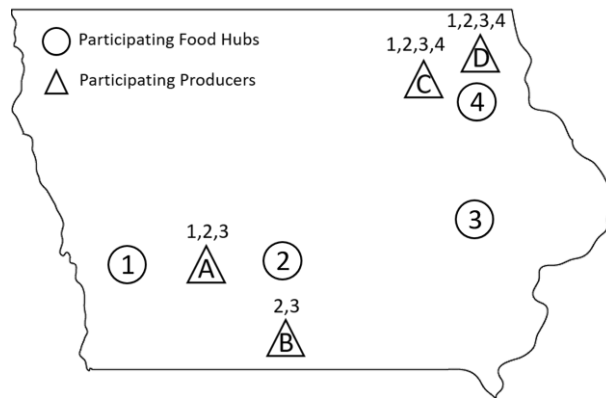


Figure 2: Participating producers and food hubs in the pilot study

The next step was to develop an inventory tracking system that would facilitate a more strategic level of collaboration in the Iowa RFSC. This system would require greater interdependence among the food hubs, and it would involve more sensitive information sharing and cooperation among the network participants. In an effort to formalize the strategic collaboration, the authors are currently developing an inventory tracking system with a mobile app and a desktop interface that will enable the producers and food hubs to track the movement of products in real time. The app will also allow participants to enter information/photos if any problems occur with customer orders, which will give the food hub managers a chance to take corrective action early. It will also help to identify the location of boxes that have gone missing while in transit.

With the Iowa food hub network now successfully moving toward a strategic-level relationship, the idea of achieving a co-evolution model of collaboration was broached, via the creation of a pooled inventory system for the entire network. Creating a pooled inventory system would impose a high degree of interdependence between participants in the network, since it requires that they share all information pertaining to their existing inventories. However, a joint conversation with the food hub managers made it clear that it would not be possible to create a pooled inventory system for the network at this time. One challenge was that all of the food hubs have different pricing policies for their producers and customers. Additionally, the food hubs are not currently competing directly

for customers, since their delivery regions are fairly small and do not overlap. A pooled inventory system could initiate direct competition between the food hubs, and this could potentially create conflict. Also, each food hub operates on its own order cycle timeline, which could pose a problem if customers of the earlier cycling food hubs buy up all of the inventory of a particular item, leading to stock-outs for the later cycling food hub's customers. Therefore, the food hub managers believe that inventory pooling will be infeasible, primarily because it will reduce their autonomy and existing control over the supply chain, which strongly they value [31]. As this co-evolution model is too advanced for the Iowa food hub network, another strategic-level idea will be implemented instead. In keeping with the idea of pooling inventory throughout the network, a dashboard feature will be added to the inventory tracking system. This dashboard will show the real-time excess and unmet demand of each food hub, which will enable each food hub manager to decide whether certain producers' products should be made available to the customers of other food hubs. This approach allows the food hub managers to maintain control of their supply bases.

The proposed strategic collaboration mechanisms should deliver the following anticipated improvements:

- Greater volumes of Iowa food products sold
- Increased producer selling radius
- Increased customer participation, as a result of fewer deliver errors and increased product variety from producers across the state
- Improved utilization of storage space at the food hub warehouses, as well as better scheduling of the warehouse labor, resulting from having advance knowledge of product arrival times/volumes
- More efficient communication between the food hubs
- Reduced manual labor: fewer steps required when loading/unloading products at the warehouses, automated generation of truck routes, and less time required for resolving logistics issues

System improvements will be evaluated by conducting a pre- and post-implementation survey with the producers and food hub managers.

4. Conclusion

This paper describes how horizontal collaboration between different entities at the same level in the supply chain can work together to achieve their overall business goals. Three levels of collaboration mechanisms have been studied to improve the existing collaboration efforts among four regional food hubs in Iowa. Despite significant financial constraints, the commitment of the food hub managers to promote the local food system has enabled a successful pilot study and led to the development and working implementation of a formal framework. The authors are currently developing a low-cost and easily maintainable inventory tracking system over a mobile application. This will allow participants to accurately share logistics information with one another in real time. Successful implementation of the framework will help grow the collaboration of the Iowa food hub network resulting in increased sales volumes and selling radii of the Iowa food producers. As a result, local food will be more efficiently distributed, matching more sellers to buyers, and will decrease the network's environmental impact, through pooling of resources. This kind of collaboration framework can also be adopted by other small and mid-sized enterprises located within regional proximity to increase their business efficiencies. These practices are aligned with the United Nations 2030 agenda for Sustainable Development, specifically goals of responsible consumption and production and climate action.

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